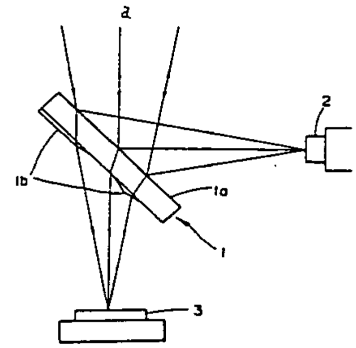
(54) **OPTICAL HEAD**
(11) **63-211130 (A)** (43) 2.9.1988 (19) JP
(21) Appl. No. 62-44210 (22) 27.2.1987
(71) SONY CORP (72) AKIO YAMAKAWA
(51) **Int. Cl⁴. G11B7/09,G02B7/11,G11B7/135**

PURPOSE: To omit a coma aberration correcting optical element, to reduce the number of parts and to easily assemble the parts by forming a wave front phase correcting layer for correcting a coma aberration on the surface of an optical element for generating astigmatism.

CONSTITUTION: The wave front phase correcting layer 1b for correcting the coma aberration of the plate-like optical element (half mirror) 1 for generating astigmatism by passing a focus error detecting reflected beam from a recording medium is formed on the surface of the optical element 1. Since harmful coma aberration secondarily generated by the optical element 1 itself can be completely removed by its own optical element 1 through the correcting layer 1b, ordinary coma aberration correcting optical parts can be omitted. Thereby, the number of parts can be reduced and assembling can be made easy because the optical element difficult in fitting adjustment can be omitted.

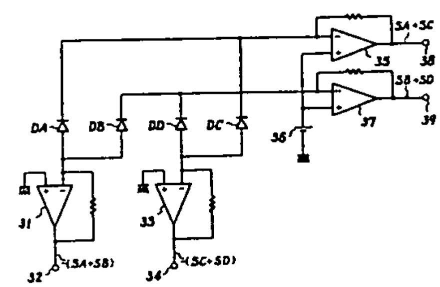


a: to collimeter lens (optical recording medium side)

(54) **OPTICAL READER**
(11) **63-211131 (A)** (43) 2.9.1988 (19) JP
(21) Appl. No. 62-44414 (22) 27.2.1987
(71) SONY CORP (72) NORIYUKI YAMASHITA
(51) **Int. Cl⁴. G11B7/09,G11B7/12**

PURPOSE: To improve the SN ratio of a reading signal and to effectively obtain a servo signal from an opposite side electrode by adding the reading signal with current on the anode side of a photodiode and extracting the current-added reading signal.

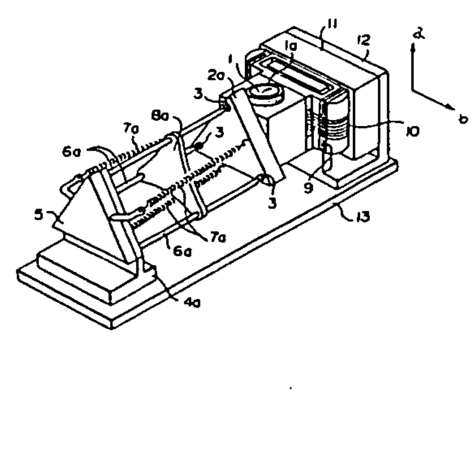
CONSTITUTION: Anodes or cathodes of respective two photodiodes DA, DC and DB, DD arranged on respectively diagonal positions out of four photodiodes DA~DD for detecting optical beams are connected and respective nodes are connected to operational amplifiers 31, 33 and 35, 37. Thereby, the photodetecting outputs of the diodes DA, DB are added about current on the anode side and the added output the inverse of (SA+SB) is obtained from an output terminal 32 through the amplifier 31. Similarly, an added output the inverse of (SC+SD) is obtained from an output terminal 34. Thereby, the S/N ratio of a reading signal can be improved by 3dB as compared to an ordinary case amplifying a reading signal by individual amplifiers and a servo signal is effectively obtained on the opposite side electrode.



(54) **OPTICAL SYSTEM DRIVER**
(11) **63-211132 (A)** (43) 2.9.1988 (19) JP
(21) Appl. No. 62-43127 (22) 27.2.1987
(71) CANON ELECTRONICS INC (72) TAKESHI SAKUMA(1)
(51) **Int. Cl⁴. G11B7/09**

PURPOSE: To assemble the titled device within a short period without using a highly accurate jig by coupling a movable member with a base by three coupling members born by pivots and forming a prescribed elastic member.

CONSTITUTION: The movable member 2a fixing an objective lens holder 1a is coupled with the spring base 5 by three coupling members 6a born by the pivots and the member 2a and the base 5 are excited in an mutually pulling direction by the tensile force of three coil springs 7a. A rubber damper 8a is fitted to the center of the coupling members 6 so as to have a dumping effect against torsion or vibration generated at the time of driving. The improvement of the link system can prevent the generation of sub-resonance or excess vibration mode, a highly accurate high can be omitted at the time of assembling by securing the accuracy of respective parts, and the assembling can be simply attained within a short time.



a: focus direction, b: track direction

PATENT ABSTRACTS OF JAPAN

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(71)Applicant : **SONY CORP**

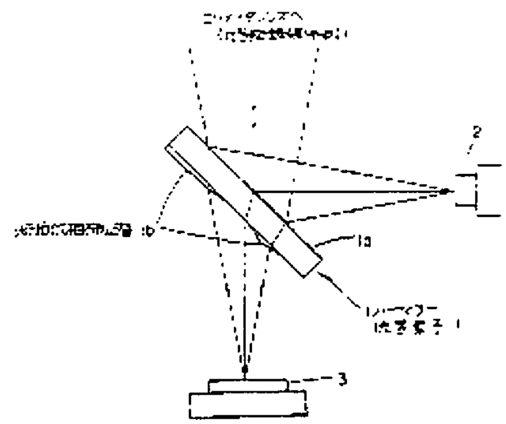
(72)Inventor : **YAMAKAWA AKIO**

(54) **OPTICAL HEAD**

(57)Abstract:

PURPOSE: To omit a coma aberration correcting optical element, to reduce the number of parts and to easily assemble the parts by forming a wave front phase correcting layer for correcting a coma aberration on the surface of an optical element for generating astigmatism.

CONSTITUTION: The wave front phase correcting layer 1b for correcting the coma aberration of the plate-like optical element (half mirror) 1 for generating astigmatism by passing a focus error detecting reflected beam from a recording medium is formed on the surface of the optical element 1. Since harmful coma aberration secondarily generated by the optical element 1 itself can be completely removed by its own optical element 1 through the correcting layer 1b, ordinary coma aberration correcting optical parts can be omitted. Thereby, the number of parts can be reduced and assembling can be made easy because the optical element difficult in fitting adjustment can be omitted.



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* NOTICES *

CLAIMS

[Claim(s)]

[Claim 1] The multilayer mirror for X-rays characterized by to have been formed on a substrate, and only for a predetermined angle to incline and form the front face of the aforementioned multilayer to the interface of each class which constitutes the aforementioned multilayer in the multilayer mirror equipped with the multilayer which comes by turns to carry out the laminating of the second layer which the first pass and the aforementioned difference which the difference of the rate of an optical refraction which has the wavelength of an X-ray field, and the refractive index in a vacuum turns into from the small matter become from the large matter

[Claim 2] The multilayer mirror for X-rays characterized by setting up the aforementioned predetermined angle which the interface of each class and the front face of the aforementioned multilayer which constitute the period of the aforementioned multilayer and this so that the X-ray reflected on the front face of the aforementioned multilayer may be reflected along the direction of a normal on this front face of a multilayer in the multilayer mirror for X-rays according to claim 1 make.

[Claim 3] The reflected type X ray mask which X-ray the non-reflecting section which does not reflect an X-ray in a part of aforementioned multilayer of the multilayer mirror for X-rays according to claim 1 is formed, and comes to form the aforementioned X-ray non-reflecting section in a predetermined pattern.

[Claim 4] In the manufacture method of the multilayer mirror for X-rays equipped with the process which carries out the laminating of the second layer which the first pass and the aforementioned difference which the difference of the rate of an optical refraction which has the wavelength of an X-ray field, and the refractive index in a vacuum turns into from the small matter become from the large matter by turns on a substrate, and forms a multilayer The manufacture method of the multilayer mirror for X-rays characterized by preparing the substrate which has the inclined plane which inclines with a predetermined angle to a flat side and this flat side, forming the aforementioned first pass and the second layer by turns toward the aforementioned flat side from the aforementioned inclined plane, and forming the aforementioned multilayer.

[Claim 5] In the manufacture method of the multilayer mirror for X-rays equipped with the process which carries out the laminating of the second layer which the first pass and the aforementioned difference which the difference of the rate of an optical refraction which has the wavelength of an X-ray field, and the refractive index in a vacuum turns into from the small matter become from the large matter by turns on a substrate, and forms a multilayer After forming the aforementioned first pass and the second layer by turns along the flat side established on the aforementioned substrate and forming the aforementioned multilayer, The manufacture method of the multilayer mirror for X-rays characterized by removing a part of aforementioned multilayer so that the interface of aforementioned each class and the front face of the aforementioned multilayer which constitute this multilayer may incline with a predetermined angle.

[Claim 6] The manufacture method of the multilayer mirror for X-rays characterized by grinding the aforementioned multilayer along with the polished surface which makes a predetermined angle to the interface of aforementioned each class which constitutes the aforementioned multilayer in the manufacture method of the multilayer mirror for X-rays according to claim 5.

[Claim 7] In the manufacture method of the multilayer mirror for X-rays according to claim 5, a cross-section V character type slot is arranged by the single dimension a fixed period. The manufacture method of the multilayer mirror for X-rays characterized by for one field preparing the substrate each other arranged in parallel, forming the aforementioned first pass and the second layer by turns along aforementioned one field of this substrate, and forming the aforementioned multilayer among the fields of the couple which constitutes each slot.

[Claim 8] The manufacture method of the multilayer mirror for X-rays which shifts the cut aforementioned multilayer mutually in the direction of a laminating, joins, and is characterized by removing a part of joined multilayer in the manufacture method of the multilayer mirror for X-rays according to claim 5 after cutting the aforementioned multilayer in the thickness direction of the aforementioned multilayer with a substrate.

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the manufacture method of the reflected type mask in the X-ray projection exposure using the multilayer mirror for X-rays used for the catoptric system in the wavelength field of X-rays, such as X-ray projection exposure and an X-ray microscope, and this multilayer mirror for X-rays, and the multilayer mirror for X-rays.
[0002]
[Description of the Prior Art] This kind of multilayer mirror for X-rays carries out the laminating of two kinds of matter which a refractive index is large and is different by turns by the thickness of severalangstroms - dozens of A on a substrate. if the multilayer mirror for X-rays uses the interference effect of light reflected by many interfaces, wavelength of theta and an X-ray is set [the length (cycle length) of one period of a multilayer] to lambda for the incident angle of d and an X-ray and a Bragg's condition (2d sintheta=nlambda) will be filled, it will come, and it shows a high reflection factor
[0003] Drawing 11 is the outline cross section showing the conventional multilayer mirror for X-rays. In this drawing, an X-ray multilayer mirror is equipped with the multilayer 1 formed on the front face 5 of a substrate 2, and it comes by turns to form the layers 19 and 20 which consist of two kinds of matter with which a refractive index (namely, ratio of the rate of an optical refraction which has the wavelength of the X-ray field to the refractive index in a vacuum) is large, and these multilayers 1 differ. Since the conventional multilayer mirror for X-rays has the parallel interface 4 (that is, interface of layers 19 and 20) of a multilayer 1 on the surface of [3] a mirror, it reflects an X-ray only in the symmetrical direction to the normal N of the front face 3 of a mirror. That is, incidence X-ray 6 and reflective X-ray 7 are in a symmetric position on both sides of Normal N. Therefore, it is used for a multilayer mirror changing the sense to which light progresses like the mirror generally used to the light when a surface configuration is a flat surface, or changing the breadth of light in the case of a curved surface. Furthermore, it is applied also to the microscope for X-rays, or the image formation optical system of projection exposure by combining the multilayer mirror of a curved surface.
[0004] The multilayer mirror for X-rays shown in drawing 11 can also be used as a mask in X-ray projection exposure. Conventionally, in X-ray projection exposure, the penetrated type mask which formed the desired pattern by the thin film member which consists of matter which cannot penetrate an X-ray easily on self-supported film (membrane) with a thickness of about 2 micrometers it is thin from the matter which an X-ray tends to penetrate has been used. However, this mask had troubles -- it is easy to produce deformation by the heat generated when production of the mask of a large area being difficult and an X-ray are irradiated, since the intensity of a membrane is very weak.
[0005] Then, in order to solve such a trouble, the reflected type mask as shown in drawing 12 (a), (b), and (c) is proposed. What drawing 12 (a) removed a part of multilayer 1 by etching etc., and formed the pattern, the thing which this drawing (b) carried out the laminating of the thin film 8 which absorbs an X-ray on a part of front face of a multilayer 1, and formed the pattern, and this drawing (c) form a pattern by the multilayer 26 which destroys a part of periodic structures of a multilayer 1 with an ion implantation etc. and by which periodic structure was destroyed. Since the thick substrate 2 can be used for each mask shown in drawing 12 (a), (b), and (c) instead of a thin membrane, the above-mentioned trouble is not produced.
[0006]
[Problem(s) to be Solved by the Invention] The schematic diagram of the optical system of X-ray projection exposure using the penetrated type mask and the reflected type mask is shown in drawing 4 . As for 9, in drawing 4 , a penetrated type mask and 10 are the reflected type masks with which illustrated an image formation side and 12 through the X-ray, and image formation optical system and 11 illustrated 13 by drawing 12 . With the penetrated type mask 9, since the transmitted light of X-ray 12 is used, it can arrange so that the flat surface (namely, front face of a mask 9) which a

pattern arranges as shown in drawing 4 (a) may become perpendicular to the optical axis of X-ray 12. On the other hand, with the conventional reflected type mask 13, since an incident light and the reflected light will lap if the front face (flat surface which a pattern arranges) of a mask 13 is made perpendicular to the optical axis of X-ray 12 (refer to drawing 11), as shown in drawing 4 (b), the direction of a normal of the front face of a mask 13 must arrange a mask 13 in the state where it inclined to the optical axis.

[0007] Although the distance of each point of the front face of a mask 9 and the image formation optical system 10 is fixed in the case of the penetrated type mask 9, only the part which leans to the optical axis of X-ray 12 becomes therefore, less fixed in the case of the reflected type mask 13. Therefore, when the reflected type mask 13 is used, you have to have the big depth of focus to which the focus of image formation optical system 10 suits to the whole surface of the portion of a mask 13 or the mask 13 currently illuminated. The depth of focus D required of the image formation optical system 10 when the reflected type mask 13 is used is [Equation 1] when a mask 13 is made into the square of one side l.

D=l sin (90-theta) .... (1) theta: -- it becomes the oblique incidence angle which X-ray 12 and the front face of a mask 13 make (1) It is necessary to enlarge the depth of focus D, so that he can understand from a formula and a mask 13 becomes large. Moreover, although the depth of focus D becomes small so that theta is close to 90 degrees, an experience top is difficult for making theta in practice larger than about 87 degrees from the limit by arrangement of an illumination system. For example, when carrying out X-ray reduction exposure of the pattern formed in the with an one-side square [10mm square] reflected type mask 13 with optical system with a scale factors [1/5] and a resolution of 0.1 micrometers by theta= 87-degree arrangement, since the scale factor of 500 micrometers or more and the image formation optical system 10 is 1/5 in a mask side, the depth of focus D of the image formation optical system 10 is needed from (1) formula, more than 20 micrometer (=500x(1/5 On the other hand, in such image formation optical system 10, the realizable depth of focus D is 1 micrometer or less in an image side. Therefore, it is very difficult to produce the optical system which combines the above high resolutions and the big depth of focus.

[0008] There is the method of exposing a large area by carrying out the scan of a mask and the wafer, illuminating some masks other than the method of carrying out package exposure of the above large areas to ring band-like as the method of exposure X-ray reduction projection exposure, and exposing a wafer (for example, refer to a Solid State Technology Japanese version, p.19-25, and 1991 September). This method has the advantage that production of the image formation optical system which illuminates some masks to ring band-like is easy. When illuminating a mask to ring band-like, the width of face of **** is equivalent to l of the above-mentioned (1) formula. However, when, carrying out X-ray reduction exposure for example, using optical system with a scale factors [1/5] and a resolution of 0.1 micrometers by the arrangement whose width of face of **** is 0.5mm and theta= 87 degrees, the depth of focus of optical system is needed more than 1 micrometer (500x (1/5)) by the wafer side. Therefore, when producing an aligner with optical system with a depth of focus of about 1 micrometer, a focus must suit only by one specific point, and a highly precise alignment precision with almost difficult realization is required. Although the depth of focus D can be made small and the burden to optical system can be made light if width of face of **** is made still smaller Since it is difficult for production of lighting optical system to become [the width of face of ****] small difficult by the bird clapper, and to reduce the X-ray intensity of the whole **** from the point of a throughput, If the width of face of **** becomes small, the irradiation X-ray intensity per unit area of the part mask will increase, and this will also produce the problem of the endurance of a mask.

[0009] As mentioned above, in the X-ray projection exposure with the conventional reflected type mask, a high alignment precision was needed compared with the penetrated type mask, and there was a trouble of requiring the big depth of focus also of image formation optical system.

[0010] The purpose of this invention is to offer the manufacture method of the possible multilayer mirror for X-rays of making the flexibility of the relative arrangement relation between a reflected type mask and image formation optical system increase, a reflected type mask, and the multilayer mirror for X-rays.

[0011]

[Means for Solving the Problem] this invention is applied to the multilayer mirror for X-rays equipped with the multilayer which comes by turns to carry out the laminating of the second layer which the first pass and the aforementioned difference which the difference of the rate of an optical refraction which has the wavelength of an X-ray field, and the refractive index in a vacuum turns into from the small matter become from the large matter on the substrate. And the above-mentioned purpose is attained when only a predetermined angle inclines and forms the front face of the aforementioned multilayer to the interface of each class which constitutes the aforementioned multilayer. Moreover, the aforementioned predetermined angle which the interface of each class and the front face of the aforementioned multilayer which constitute the period of the aforementioned multilayer and this so that the X-ray reflected on the front face of the aforementioned multilayer may be reflected along the direction of a normal on this front face of a multilayer make was set up. Furthermore, X-ray the non-reflecting section which does not reflect an X-

ray in a part of aforementioned multilayer of the multilayer mirror for X-rays was formed, formation formation was carried out and the aforementioned X-ray non-reflecting section was used as the reflected type mask at the predetermined pattern.

[0012] Moreover, since the above-mentioned multilayer mirror cannot be manufactured by the manufacture method of the conventional multilayer mirror, a method which is described below is needed. As one of the above-mentioned methods, the slit has been arranged on a substrate at the time of thin film formation of a multilayer mirror, and the method of moving it in parallel with a substrate front face was devised.

[0013] First, the substrate 2 of a cross-section configuration as shown in drawing 6 (b) is prepared. A part of front face of this substrate 2 is formed in the inclined plane 16 which inclines at an angle of [phi] predetermined to other front faces (flat side) 17. This angle phi is made equal to the angle phi (refer to drawing 1) which the front face 3 of the multilayer mirror 14 for X-rays which should manufacture, and the interface 4 of a multilayer 1 make. Next, the slit board 15 as shown on this substrate 2 at drawing 6 (a) is arranged. Slit 15a of a plane view rectangle is formed in the slit board 15, and the width of face a of this slit 15a is t, then the following formula [several 2] about the thickness of the multilayer 1 whole.

A=t/tan phi .... It is set by (2). On the contrary, the thickness t of a multilayer 1 can be adjusted by defining the size of a. The width of face b of the inclined plane 16 of a substrate 2 should be just larger than a.

[0014] Next, the laminating of the multilayer 1 is carried out in the following procedures by the spatter etc. First, as shown in drawing 7 (a), the slit board 15 is arranged so that slit 15a may be located on the inclined plane 16 of a substrate 2. And carrying out the horizontal displacement of the slit board 15, the laminating of the spatter particle 18 is carried out to the front face 16 of a substrate 2 from slit 15a, the first pass 19 of a multilayer 1 is formed, as shown in drawing 7 (b), when the first pass 19 becomes the desired thickness d1, the membrane formation work of the first pass 19 is suspended, and the horizontal displacement of the slit board 15 is stopped simultaneously. For the during-this-period and slit board 15, horizontal displacement is carried out at uniform velocity, and the speed is distance [several 3].

P=d1/sin phi .... It considers as the speed which broke (3) by time to form the first pass 19 further. 20 [layer / second] is formed carrying out the horizontal displacement of the slit board 15, similarly, as shown in drawing 7 (c), when 20 / layer / second] becomes the desired thickness d2, the second layer of the membrane formation work of 20 is suspended, and the horizontal displacement of the slit board 15 is stopped simultaneously. Above, the laminating of the round term of a multilayer 1 can be carried out. The same operation as **** is repeated hereafter, and the multilayer mirror 14 for X-rays as shown in drawing 1 is obtained by carrying out the laminating of the multilayer 1 all over a substrate 2. Moreover, if the front face 3 of a mirror 14 is ground after membrane formation, surface roughness becomes small and can improve the reflection factor of a mirror 14.

[0015] The multilayer 1 produced by the above-mentioned method has the fixed thickness within a mirror side like the conventional multilayer 1. Therefore, it is not concerned with the size of thickness but the reflection factor within a field is fixed. Moreover, a multilayer which will be easy to exfoliate if thickness is enlarged according to internal stress being large, since arbitrary thickness can be chosen can also be produced by making the thickness small. When using the multilayer mirror 14 for X-rays shown in drawing 1 as a reflected type mask 13, pattern formation is possible by the same technique as the conventional mask 13 shown in drawing 12 .

[0016] Moreover, there is the method of removing from the multilayer mirror manufactured as usual as the another manufacture method, after forming a part of multilayer. The following methods are included in this method. One is the method of leaning and arranging the formed multilayer mirror to a multilayer front face, and grinding the front-face side of a multilayer. As shown in drawing 8 (a), on the substrate 2 of the cross-section configuration by which the front face 16 was formed in the inclination flat surface to which only the angle phi inclined to base 2a of a substrate 2, by the spatter etc., this method carries out the laminating of the multilayer 1, as first shown in drawing 8 (b), as shown at drawing 8 (c), grinds the front face aslant, and removes a part of multilayer 1 21 aslant.

[0017] Although the angle phi which the front face (inclined plane) 16 of a substrate 2 makes is equal to the angle which the front face 3 of a mirror 14 and the interface 4 of a multilayer 1 make, this is because a polished surface is made parallel and can be performed to base 2a of a substrate 2 in the work which removes a part of multilayer 1 21 by polish. Therefore, without making the front face 16 of a substrate 2 incline, membranes may be formed to an parallel flat-surface substrate, and only an angle phi may lean and grind it. Moreover, this method has the feature that the multilayer mirror of what must carry out the stacked-volume layer of many multilayers if an angle phi becomes large can be manufactured very easily. Therefore, this method is suitable for manufacture of a mirror with a small angle phi, and a mirror with a small area.

[0018] The another manufacture method is the method of forming a multilayer 1 on the substrate 2 which has a cross-section configuration as shown in drawing 9 (a). That is, on this substrate 2, as the substrate 2 in which one front face 22 was formed mutually and in parallel among two front faces 22 and 23 which arranges the V character type slot G to

a single dimension a fixed period so that a field parallel to base of substrate 2 2a on the front face of a substrate 2 may not remain, and constitute each slot G is prepared and it is shown in drawing 9 (b), the laminating of the multilayer 1 is carried out by the spatter etc. If polish etc. is given to the front face of a multilayer 1 and it removes surface [a part of] after carrying out a laminating, the multilayer mirror 14 as shown in drawing 9 (c) will be obtained. This method has the feature that few laminatings may be compared with the above-mentioned method (method according to claim 6), when obtaining the thickness t of the same multilayer 1. Therefore, a mirror with a big angle phi and a mirror with a big area can be manufactured easily. Moreover, if the direction of incidence of the laminating particle 18 is made parallel on a front face 23 by the spatter etc., a particle will not adhere to the substrate side 23, but it will be easy to obtain the mirror of a high reflection factor. Moreover, although the reflection factor of the multilayer mirror 14 becomes small in the position of each peak 24 of a substrate 2 when there are few number of layerses, if a number of layers is made [many / sufficiently], a reflection factor will be saturated and the reflection factor of a mirror 14 will become fixed in a field. Since the reflection factor of a mirror 14 furthermore serves as the maximum at this time, as for a number of layers, it is desirable to make it the grade with which a reflection factor is saturated.
[0019] Moreover, the another manufacture method is a method of manufacturing the multilayer mirror 14 as set to two or more mirror 14a which cuts the conventional multilayer mirror as shown in drawing 11 by the cutting plane 25 which met in the thickness direction as shown in drawing 10 (a), and has minute width of face, shifted and joined them in the direction of a laminating of a multilayer 1 as again shown in drawing 10 (b), ground a front face and shown in drawing 10 (c). The amount q to shift is the following formula [several 4]. Q=rtan phi .... It is given on the square which the width of face of the mirror of which (4) r:cutting was done, and the interface 4 of the phi:multilayer 1 make, and, as for the thickness t of a multilayer 1, it is desirable that it is larger than q. These methods are applicable not only to a flat-surface substrate but a curved-surface substrate.
[0020]
[Function] In this invention, as shown in drawing 1 , to the reflector (interface) 4 of each class 19 and 20 from which the mirror front face 3, i.e., a multilayer front face, constitutes a multilayer 1, only an angle phi inclines and is formed. Therefore, unlike the angle theta of X-rays 6 and 7 to the reflector 4 of a multilayer 1, angle thetaI to the mirror front face of an incidence X-ray and a reflective X-ray and thetaR become theta I=theta-phithetaR=theta+phi. Thereby, the multilayer mirror 14 by this invention can reflect X-ray 6 asymmetrically to the mirror front face 3. The schematic diagram of an X-ray projection aligner using the reflected type mask 13 which formed the pattern in the multilayer mirror 14 by this invention as shown in drawing 2 and drawing 3 is shown in drawing 4 (c). Angle thetaR of a reflective X-ray can be made into 90 degrees by setting up suitably the period of a multilayer 1, and inclination phi of a multilayer 1. Thereby, a mask 13 can be arranged so that the front face of a mask 13 may become perpendicular to the optical axis of the image formation optical system 10.
[0021] In addition, although drawing of an example was used by the term of the above-mentioned The means for solving a technical problem explaining the composition of this invention, and an operation in order to make this invention intelligible, thereby, this invention is not limited to an example.
[0022]
[Example]
- 1st example- drawing 2 is the outline cross section showing the 1st example of this invention. This view shows the reflected type mask which formed the multilayer 1 in the shape of [desired] a pattern on the substrate 2. 3 degrees of interfaces 4 of a multilayer lean to the front face (that is, multilayer front face 3) of a reflective mask, or the front face 5 of a substrate. The manufacture method of this reflected type mask is explained below.
[0023] First, the substrate 2 of a configuration as shown in drawing 6 (b) is prepared. Although surface size is 20x20cm, 3 degrees of this substrate 2 lean to the front face 17 of others [front face / the / (inclined plane) / a part of / 16]. Next, the slit board 15 with which slit 15a of a rectangle as shown in drawing 6 (a) was formed on this substrate 2 has been arranged. Although the width of face a of this slit 15a should just be below the width of face b of an inclined plane 16, by this example, a and b set it to 6.2 micrometers. Next, the laminating of the multilayer (Mo/Si) 1 which consists of a molybdenum layer 19 and a silicon layer 20 was carried out by the spatter, carrying out the horizontal displacement of the slit board 15. The thickness d1 and d2 of molybdenum and silicon could be 25 or 42A, respectively. Above, the multilayer mirror 14 for X-rays as shown in drawing 1 is obtained. Next, etching removed a part of this multilayer 1. First, the resist was applied to the front face of a mirror 14, and the pattern of 0.5 micrometers of minimum line widths was printed by the reduction projection aligner which used ultraviolet rays for this. The resist was removed after **********ing a multilayer by the ion milling system furthermore. The reflected type mask 13 as shown in drawing 2 was obtained the above result. In addition, the surface portion 16 to which the substrate 2 inclined is not used as a mirror 14 and a reflected type mask 13.
[0024] The wavelength of 130A and the soft X ray 6 of 0.5x0.5mm of beam sizes were irradiated at this mask, and reduction exposure was carried out on the silicon wafer which applied the resist with the resolution of 0.1 micrometers,

scale factors 1/5, and the optical system 10 with a depth of focus of 1 micrometer. At this time, the mask 13 has been arranged so that the reflected light 7 of a mask 13 may become perpendicular to a mask front face (mirror front face 3) (refer to drawing 2). Consequently, the 0.1-micrometer pattern was formed in the 0.1x0.1mm field. Furthermore, the same result was obtained even if it moved **0.5 micrometers of wafers perpendicularly to the optical axis.
[0025] Although what is equivalent to drawing 12 (a) as a pattern of a mask was produced in this example, the mask by this invention can be adapted not only for such a pattern configuration but the mask of the thing equivalent to drawing 12 (b) and (c), or a gestalt similar to these. Moreover, the mask by this invention can be adapted not only for a flat-surface mask like this example but the mask of a curved-surface configuration.
[0026] - 2nd example- drawing 3 is the outline cross section showing the 2nd example of this invention. The laminating of the multilayer 1 is carried out on the substrate 2 of a cross-section configuration which is illustrated, and this view shows the reflected type mask 13 with which it comes to form the X-ray absorption object 8 in the front face 3 at a desired pattern. 3 degrees of interfaces 4 of a multilayer 1 lean to the front face 3 of the reflected type mask 13. The manufacture method of this reflected type mask is explained below.
[0027] First, the substrate 2 which has a cross-section configuration as shown in drawing 9 (a) is prepared. The value of q and r of this substrate 2 was set to 0.52 micrometers and 10 micrometers, respectively. Moreover, the angle which the front faces 22 and 23 which form Slot G make was made into 90 degrees. Next, the 150 pair laminating of the multilayer 1 which consists of a molybdenum layer 19 and a silicon layer 20 was carried out the period of 64A by the spatter. By this example, in order that the spatter particle 18 might jump out to the perpendicular direction of a target most mostly, it has arranged and the sputtering system used by this example formed membranes so that the perpendicular direction of a target and a front face 22 might cross at right angles so that this perpendicular direction and the front face 23 of a substrate might become parallel that is,. Next, it ground so that the front face 3 of a multilayer 1 might turn into a flat surface, and the multilayer mirror 14 for X-rays was manufactured. Next, the pattern of an absorber 8 was formed in the front face 3 of this mirror 14. First, 100nm of gold was deposited as an absorber 8 on the front face 3 of a mirror 14. And the resist was applied to the front face 3 of a mirror 14, and the pattern of 0.5 micrometers of minimum line widths was printed by the reduction projection aligner which used ultraviolet rays for this. The resist was removed after **********ing a golden vacuum evaporationo film by the ion milling system furthermore. The mask as shown in drawing 3 was obtained the above result.
[0028] When the same exposure experiment as an example 1 was conducted about this mask, the same result as an example 1 was obtained. Moreover, the mask by this invention can be adapted not only for a flat-surface mask like this example but the mask of a curved-surface configuration. In addition, in this example, the front faces 22a and 22b of ******** G and interface 4 of the multilayer 1 formed on 22c may not be in agreement. In this case, each front faces 22a and 22b and near the boundary section (a dotted line B shows to drawing 9) of the multilayer 1 on 22c, the reflective conditions of a multilayer 1 may not fully be fulfilled. However, the field where reflective conditions are not fulfilled can be made sufficiently small by setting up suitably the angle phi which the period and the multilayer interface 4 of a multilayer 1 make, and when it is used as a mask 13, there is no possibility of affecting the image.
[0029] - 3rd example- drawing 8 (c) is the outline cross section showing the 3rd example of this invention. The laminating of the multilayer 1 is carried out on the substrate 2, and 5 degrees of interfaces 4 of a multilayer 1 lean to the front face 3 of a mirror 14 at this time. Below, the manufacture method of this multilayer mirror 14 is explained.
[0030] First, as shown in drawing 8 (a), to base 2a, 5 degrees of front faces 16 inclined, they were formed, and the 45800 pair laminating of the multilayer (Mo/Si) 1 to which the area of a front face 16 consists of a molybdenum layer 19 and a silicon layer 20 on the 5x substrate 2 which is 5mm was carried out the period of 96A by the spatter. Next, polish removed a part of this multilayer 1 21 so that the front face 3 of a multilayer 1 might become parallel to base 2a of a substrate 2.
[0031] When the wavelength of 130A and the soft X ray 6 of 3x3mm of beam sizes which were collimated by this multilayer mirror 14 were irradiated at incident angle thetaI=40 degree, as shown in drawing 5 , X-ray 7 reflected in the angle-of-reflection thetaR=50 degree direction. Furthermore, the beam size of reflective X-ray 7 increased to 3.6x3mm. From this, it was checked that this multilayer mirror 14 works as a beam expander.
[0032] - 4th example- drawing 10 (c) is the outline cross section showing the 4th example of this invention. This view shows the multilayer mirror 14 for X-rays in which the multilayer 1 is carrying out the laminating on the substrate 2 of a cross-section configuration as shown in drawing 10 (c). 5 degrees of interfaces 4 of a multilayer 1 lean to the front face 3 of a mirror 14. The manufacture method of this multilayer mirror is explained below.
[0033] First, the multilayer mirror which has a cross section as shown in drawing 11 is prepared. A multilayer 1 is a multilayer which consists of the molybdenum layer 19 and the silicon layer 20 of the period of 96A, and 1000 pairs, and was produced by the spatter. By the diamond cutter, this multilayer mirror was cut along with the cutting plane 25, as shown in drawing 10 (a), and two or more cutting mirror 14a was produced. At this time, width of face r of each mirror 14a was set to 100 micrometers. Next, as shown in drawing 10 (b), these mirrors 14a was joined so that 8.75

micrometers of front faces of ****** mirror 14a might shift in the direction of a laminating of a multilayer 1. Furthermore, the multilayer mirror 14 for X-rays as ground a mirror 14 and shown in drawing 10 (c) so that a front face 3 and rear-face 2a may become a flat surface was obtained. When the same experiment as an example 3 was conducted by this mirror 14, it turns out that it works as a beam expander like an example 3.

[0034] In addition, the details are not limited to each above-mentioned example, but various modifications are possible for the multilayer mirror for X-rays of this invention etc. As an example, a multilayer is not restricted to the combination of the molybdenum mentioned by this example, and silicon. Moreover, an angle phi is not restricted to the value of this example.

[0035]

[Effect of the Invention] As mentioned above, according to this invention, an X-ray can be asymmetrically reflected to a mirror front face by the multilayer mirror for X-rays. Therefore, if the reflected type mask for X-ray projection exposure is manufactured using the multilayer mirror for X-rays by this invention, the angle to the mirror front face of the reflected light can be made into 90 degrees. Therefore, the limit to alignment precision, lighting optical system, image formation optical system, etc. resulting from a mask can be made small. Moreover, by choosing suitably the angle on the front face of a multilayer to the interface of each class which constitutes the period of a multilayer, and a multilayer, it has a specific incident angle, and it becomes possible to reflect the X-ray which carries out incidence on arbitrary outgoing radiation squares, and the flexibility of arrangement of lighting optical system, image formation optical system, and a reflected type mask can be increased. Moreover, compared with an incident light, it is made small or the multilayer mirror for X-rays by this invention can enlarge the beam size of the reflected light. Therefore, the light emitted from synchrotron radiation with the fault that the beam cross section is very small can also enlarge the cross section by this mirror. When it follows, for example, this mirror is used for lighting optical system in X-ray projection exposure, there is an effect of being able to illuminate the latus field of a mask.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline cross section showing the multilayer mirror by this invention.
[Drawing 2] It is the outline cross section showing the reflected type X ray mask which is the 1st example of this invention.
[Drawing 3] It is the outline cross section showing the reflected type X ray mask which is the 2nd example of this invention.
[Drawing 4] (a) is the conceptual diagram of the reduction aligner using the reflected type mask according [mask / penetrated type / (c)] the conventional reflected type mask to this invention in (b).
[Drawing 5] It is drawing showing change of the cross section of the incidence and the reflective beam in the multilayer mirror by this invention.
[Drawing 6] The outline perspective diagram showing the slit to which (a) is used for manufacture of the reflected type X ray mask of the 1st example, and (b) are the outline perspective diagrams showing a substrate.
[Drawing 7] It is the schematic diagram showing the manufacturing process of the reflected type X ray mask of the 1st example.
[Drawing 8] It is the schematic diagram showing the manufacturing process of the multilayer mirror of the 3rd example.
[Drawing 9] It is the outline cross section showing the manufacturing process of the reflected type X ray mask of the 2nd example.
[Drawing 10] It is the schematic diagram showing the manufacturing process of the multilayer mirror of the 4th example.
[Drawing 11] It is the outline cross section showing the conventional multilayer mirror.
[Drawing 12] It is the outline cross section showing the conventional reflected type X ray mask.
[Description of Notations]
G Slot
1 Multilayer
2 Substrate
3 Mirror Front Face
4 Interface of Multilayer (Reflector)
5 Substrate Front Face
6 Incidence X-ray
7 Reflective X-ray
8 Absorber
10 Image Formation Optical System
12 X-ray
13 Reflected Type Mask
14 Multilayer Mirror
15 Slit Board
15a Slit
16 Inclined Plane
17 Flat Side
18 Spatter Particle
19 Molybdenum Layer
20 Silicon Layer
21 A Part of Multilayer

22 23 Front face
25 Cutting Plane

[Translation done.]

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㊿発明の名称　光学ヘッド

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㉒出　願　昭62(1987)2月27日

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明　細　書

1．発明の名称

光学ヘッド

2．特許請求の範囲

光路中に傾斜して配置するとともにフォーカス誤差検出用のビームを通過させ非点収差を発生させるプレート状の光学素子を備え、

この光学素子が発生するコマ収差を補正する波面位相補正層をこの光学素子の表面に形成したことを特徴とする光学ヘッド。

3．発明の詳細な説明

〔産業上の利用分野〕

本発明は、光ディスクなどを使用する光学式記録再生装置等で用いる光学ヘッドに関するものである。

〔発明の概要〕

本発明は、光学式記録再生装置等に使用される光学ヘッドにおいて、

フォーカス誤差検出用の非点収差を発生させる機能を有するプレート状の光学素子の表面に波面位相補正層を形成して、光学素子自身が発生する有害なコマ収差を補正することにより、

コマ収差補正に特別な素子を不要とし、部品の減少と組み立てを容易にしたものである。

〔従来の技術〕

従来より、光ディスクや光カードさらには光磁気ディスクなどの光学記録媒体を用いた光学式記録再生装置が知られており、これらにおいては、その記録情報の書き込み用または読み取り用として、光学ヘッドが使用されている。

光学ヘッドは、光学記録媒体に焦点を合わせた状態で、この光学記録媒体へビームを照射するとともに、光学記録媒体からの反射ビームを検出してフォーカシングなどを行っている。即ちこのビームの照射においては、光学記録媒体上で所定のスポット状態に集光する必要があり、そのためにフォーカス誤差を検出して、その誤差信号によりフォーカシングサーボをかけて対物レンズを動か

し、フォーカス誤差が零になるようにしている。このフォーカス誤差検出法の１つとして、非点収差法がある。

第４図は、このような光学ヘッドの第１の従来例である。光学記録媒体１００から反射され収束状にされたビーム１０１に対し、プレート状のハーフミラー１０２を傾斜して配置すると、ハーフミラー１０２を透過したビーム１０１′には非点収差が発生する。このビーム１０１′を４分割された検出素子（検出出力ａ，ｂ，ｃ，ｄ）を有するディテクタ１０３上に結像させることによって、（ａ＋ｃ）－（ｂ＋ｄ）の演算からフォーカス誤差が検出される。照射ビームは光源１０４から発せられ、ハーフミラー１０２で反射されてコリメータレンズ１０５で平行光とされ対物レンズ１０６を介して光学記録媒体１００上に集光される。この対物レンズ１０６がフォーカシングサーボ制御される。

上記の第１の従来例では、ビームがハーフミラー１０２を透過して非点収差を発生するとき、同時にコマ収差も発生する。このコマ収差があるとフォーカス誤差が正確に検出できなくなるので、その改善のため本出願人は先に特開昭６１－２３６０３５号公報の光学ヘッドを提案した。

第５図の第２の従来例は、その構成を示すものである。第１の従来例との差異を説明すると、ハーフミラー１０２′とディテクタ１０３との間にプレート状の光学素子１０７を光軸に対しハーフミラー１０２′と反対の方向へ傾斜して配置し、ハーフミラー１０２′の透過ビーム１０１′を透過させてディテクタ１０３へ導く。以上の構成によって、非点収差は倍増されるが、コマ収差はその向きが互いに反対であるために打ち消されて除去することができた。

［発明が解決しようとする問題点］

しかしながら、上記第２の従来例においては、コマ収差除去のために取付困難な特別な光学素子１０７を必要とする問題点を有していた。光学素子１０７のように部品が増えることは、他の部品の性能や形状，配置に無理や影響を与えて、設計上の制約を増やし、組み立てや調整の工数を増やすことになる。

本発明は、上記問題点に鑑みて創案されたものであり、非点収差発生用の光学素子とは別個の素子を用いることなく上記光学素子のコマ収差の補正を可能にし、組み立て調整を容易にした光学ヘッドを提供することを目的とする。

［問題点を解決するための手段］

上記目的を達成するための本発明の光学ヘッドの構成は、

光路中に傾斜して配置するとともにフォーカス誤差検出用のビームを通過させ非点収差を発生させるプレート状の光学素子を備え、

この光学素子が発生するコマ収差を補正する波面位相補正部をこの光学素子の表面に形成したことを特徴とする。

［作用］

本発明では、非点収差発生用の光学素子（ハーフミラーを兼ねていても良い）の表面上にそれ自身が発生するコマ収差補正用の波面位相補正部を形成することで、その光学素子をコマ収差のない自己完結型の部品とする。

［実施例］

以下、本発明の一実施例を図面に基づいて詳細に説明する。

第１図は本発明の一実施例を示す光学ヘッドの要部の構成図である。ハーフミラー１は、本発明の光学素子の一例であり、光源２からの発散ビームを第４図の第１の従来例と同様に構成されたコリメータレンズと対物レンズを介して光学記録媒体にスポット照射し、その反射光を透過させてフォーカス誤差検出用のディテクタ３に収束するビームに非点収差を与える機能を有している。ハーフミラー１は、平行板ガラスで構成され、一方の平面にビーム半透過可能なハーフミラー面１ａを形成し、他方の面にコマ収差を補正する波面位相

補正層1bをエポキシ樹脂などの樹脂または酸化シリコン(SiO_2)で形成する。この波面位相補正層1bの厚みの変化またはガラス面の変形により、非点収差とともに発生する有害なコマ収差を補正する。

ハーフミラー1は、ハーフミラー面1aをコリメータレンズ側へ向け、波面位相補正層1bを形成した面をディテクタ3側に向け、光学記録媒体から反射されるビームの光路中に斜めに配置される。実施例ではその光軸に対し45°の角度で配置され、従って光源2は、その光軸が前記光路の光軸に直交するように配置される。

第2図はハーフミラーの第2実施例である。このハーフミラー1では、波面位相補正層1aを厚み一定の膜などで近似して形成する。膜の材料は第1図の実施例と同様である。

さらに第3図は、ハーフミラーの第3実施例である。このハーフミラー1では、イオン打ち込みなどによってガラス面の表面にガラスよりも高屈折率を有する波面位相補正層を形成する。この高屈折率部分によって波面の位相を遅らせてコマ収差を補正する。

以上のように構成した実施例の作用を述べる。屈折率nの媒質中を波長λのビームが厚みtだけ進むときの位相φは$\phi = tn/\lambda$となる。ここで二つのビームを想定し、一方は空気中(n=1)を進み(位相ϕ_1)、他方は屈折率nの媒質中を進んだとする(位相ϕ_2)と、位相差は$\phi_1 - \phi_2 = t/\lambda - tn/\lambda = t/\lambda(1-n)$となる。この式から明らかなように、媒質の厚みtまたはその媒質の屈折率nを変化させることによって、波面位相の補正が可能であり、その補正によりコマ収差が補正される。第1および第2の実施例は媒質即ち波面位相補正層1bの厚みを変化させ、第3の実施例は屈折率を変化させる。もちろん、その変化量は実験や計算によって求めることができ、その変化量に基づいてコマ収差の補正に対応した加工をガラス板表面に施せば良い。

この実施例では、ハーフミラー1が本来の機能としての非点収差を発生するとともに、それに伴って発生しフォーカス誤差検出にとって悪影響のあるコマ収差をそれ自身において補正するという自己完結型の部材とすることができる。従って、コマ収差の影響を除くために他の部材を必要とせず、他の部材に無理な性能や形状,配置を要求することがない。

なお、本発明は上記実施例に限るものではなく、その主旨に沿って種々の光学ヘッドに適用可能であり、種々の実施態様を取り得るものである。例えば、光学素子の材質はガラスに限るものではなく、光路中の傾斜角も45度に限るものでもない。

[発明の効果]

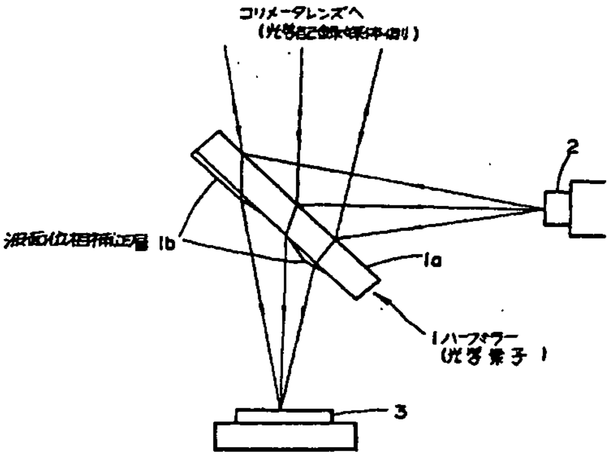
以上の説明で明らかなように、本発明の光学ヘッドによれば、フォーカス誤差検出のための非点収差発生用の光学素子自身で二次的に生ずる有害なコマ収差を光学素子自身が自己完結的に除去するので、従来のコマ収差補正用の部品が不要となり、部品を減少させるとともに、その部品のむずかしい取り付けや調整をも省くことができる。また、部品の追加がないので、他の部品に対しその性能や形状,配置に無理や影響を与えることがない。

4.図面の簡単な説明

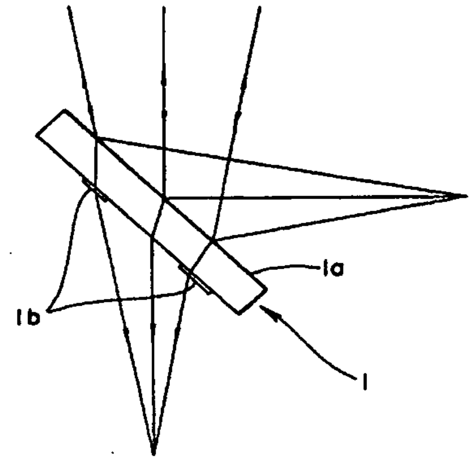
第1図は本発明の一実施例の要部構成図、第2図は光学素子の第2実施例、第3図は光学素子の第3実施例、第4図は第1の従来例、第5図は第2の従来例である。

1…ハーフミラー(光学素子)、1b…波面位相補正層。

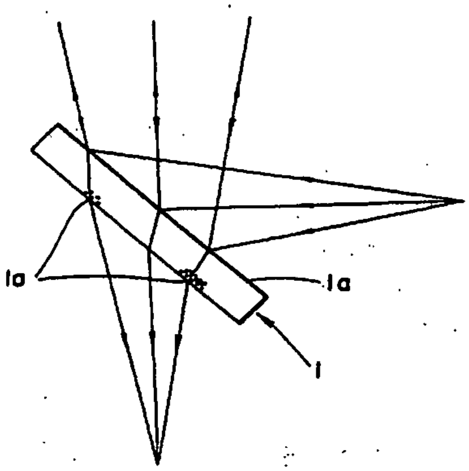
代理人　志賀富士弥



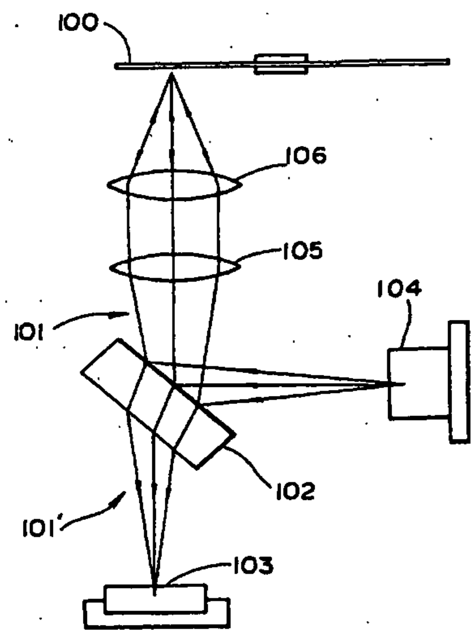
一実施例の要部構成図
第1図



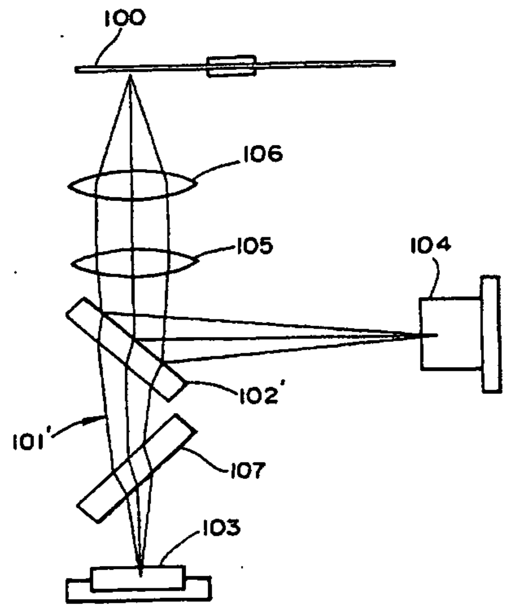
光学素子の第2実施例
第2図



光学素子の第3実施例
第3図



第1の従来例
第4図



第2の従来例

第 5 図